

THE LIMP LADDER (A)

An Investigation of Collapse of an Extension Ladder  
While Being Used.

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Names, but not facts or observations, have been disguised.

One day Mr. Jones, a professional engineer, had a call from Mr. Bangs of the PDQ Insurance Company. A Mr. Hopper had filed a claim relative to injuries sustained when a ladder collapsed when Mr. Hopper was using it. Mr. Bangs asked Mr. Jones to investigate the situation and report his findings.

## INVESTIGATION

### The Circumstances

Mr. Hopper was carrying bundles of roofing shingles up a ladder to the roof of a house when the ladder collapsed. The bundles of new roofing shingles were in the driveway (see Fig. 1) and Mr. Hopper had placed the ladder fairly close to the shingles to minimize the work he would have to do. The distance from the driveway to the bottom of the first tier of siding shingles was 84 inches. Each tier of siding shingles was 14 inches high. The distance from the driveway to the underside of the gutter is about 16 1/2 feet.

### Description of Ladder Damage

The damage observed in the subject ladder is shown clearly in Figures 2, 3 and 4. The siderails of the fly section are bent and twisted to the side at the point of overlap with the base section. It is noted that the bends and twists in these rails took place in a zone on the fly section where the rung spacing is 24 inches instead of 12 inches.

### Observations of the Ladder

The ladder is a 20 ft., two section extension ladder made of light-weight metal, presumably an aluminum or magnesium alloy. One siderail has a decalcomania labeled:

"Sears Ladder  
Medium Duty"

The "decal" also lists instructions for proper and safe use of the ladder (See Figure 5). The characters:

"20 FT"  
and  
"42164"

were stamped on the same siderail.

Width of the ladder base section is 15 inches, width of the fly section is 13 7/8 inches. Rung spacing is 12 inches on centers. The ladder is equipped with rung hooks which are spring loaded for positive clamping action and with pivoting rubber feet.

The ladder was extended to 18 feet with an overlap of 2 feet.

The ladder conforms to structural and dimensional requirements for portable metal ladders specified by the American National Standards Institute, i.e., ANSI Standard A14.2-1972.

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You are employed by Mr. Jones and accompanied him when he went to investigate this situation. He asks you to draft a report (discussion and conclusions) to be sent to Mr. Bangs of PDQ Insurance Company.



Fig. 1 Accident site showing driveway, building wall, and roof to which bundles of roofing shingles were being carried from the driveway.



F.D. 5



Fig. 2 View of damaged ladder. Bottom (or foot) of ladder is at the bottom of the photograph.





Fig. 3 Closer view of damaged section of the ladder looking from bottom end toward the top.





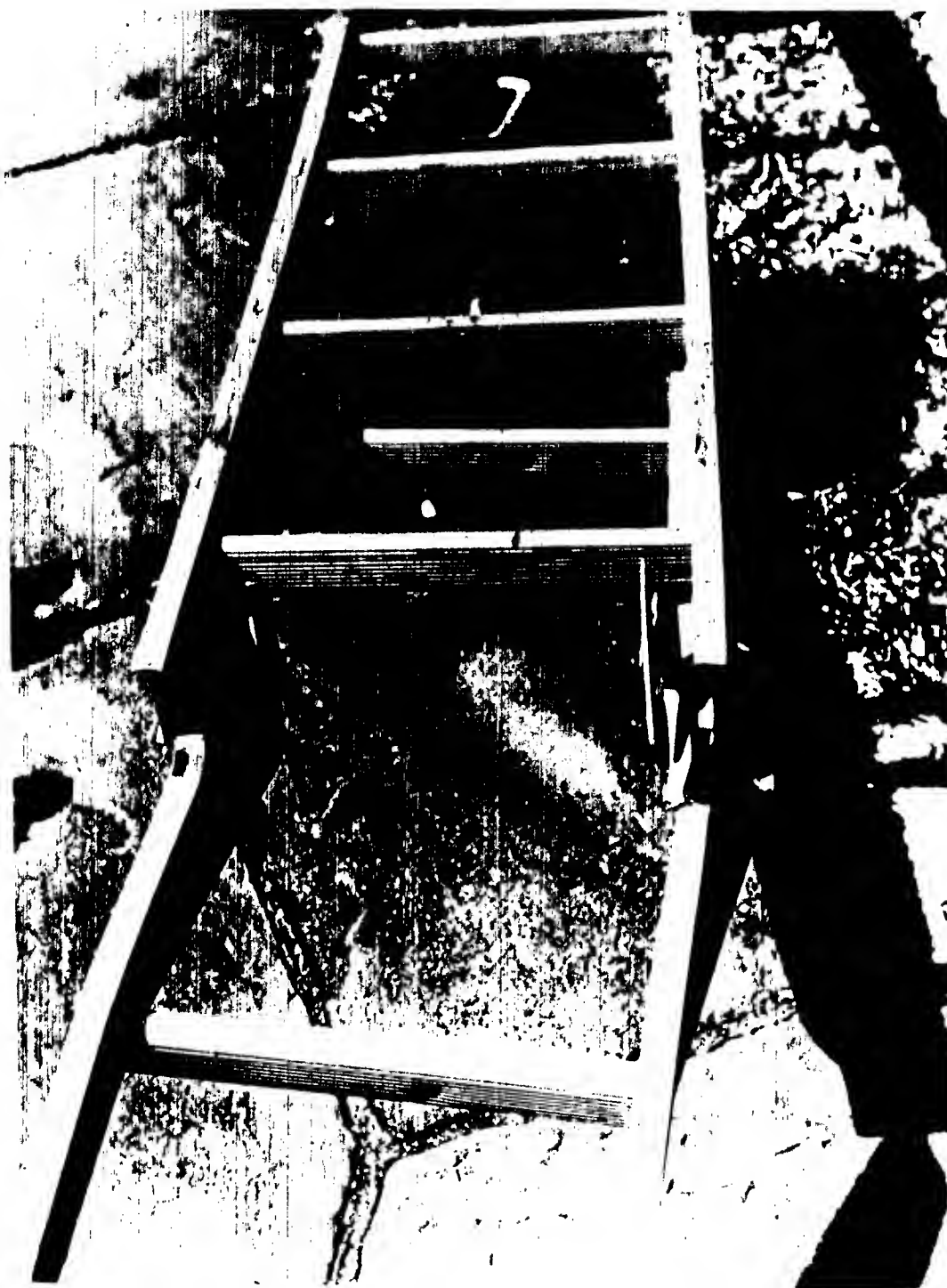


Fig. 4 Closer view of damaged section of the ladder looking from top end toward the bottom.



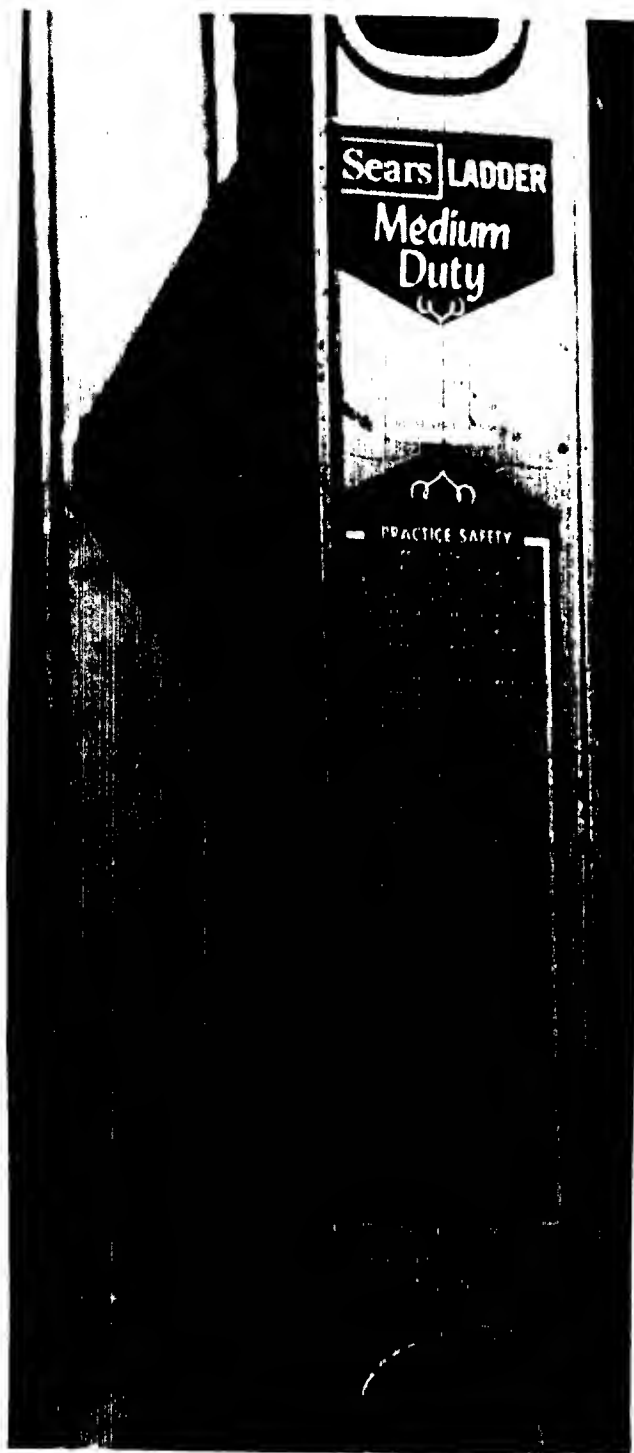


Fig. 5 Close up view of a section of the siderail showing a decalcomania (rewritten for reading clarity).

This fine ladder was thoroughly inspected and shipped in 1st class condition.

FOR SATISFACTION AND YOUR SAFETY...

1. Inspect fully, both on receipt and before each use, never use any ladder unless it is in 1st class condition.
2. Use ladder only on a firm, level surface.
3. Keep ladder close to your work area and don't over-reach. Instead, move ladder when necessary.
4. Face ladder when climbing or descending. Do not adjust extension ladders from above.
5. Do not overload this ladder. It is designed to hold only one person.
6. Keep ladder clean and free of mud, grease, and ice which may cause you to slip. For wood and aluminum ladders, lubricate moving metal parts with light oil, and wax or soap top of locks to slide over rungs easier.
7. STEPLADDERS: Make sure ladder is fully open and in locked position. NEVER stand on top step or pail shelf.  
EXTENSIONLADDERS: NEVER stand on top rung. For safe working angle, place bottom 1/4 of its working length (base to top support) away from wall. Ladder should extend 3 feet above roof or upper support. Minimum overlap between sections as follows:
  - up to 32 feet....3 foot overlap
  - 36 to 40 feet....4 foot overlap
  - up to 48 feet....5 foot overlap
8. Do not let any ladder come in contact with electric wires. Do not use metal ladder when making electrical repairs or installations.
9. To prolong metal ladder life and appearance, apply clear protective coating as a preservative to wood ladders.



**Sears Roebuck**  
**Medium Duty**



**PRACTICE SAFETY**

Always use ladder only thoroughly inspected and shown to be safe condition.  
Never use ladder on uneven ground.  
Always use both feet on rungs and keep both feet on rungs at any time.  
Never use any part of ladder except as intended.  
Use ladder only on a firm, level surface.  
Keep ladder close to you with one end and don't overreach. Instead, move ladder when necessary.  
1. Push ladder when climbing or descending. Do not allow someone to lean over ladder.  
2. Do not overload the ladder. It is designed to hold only one person.  
3. Keep ladder close and free of wall, pipes, and so on when using. Keep feet on rungs and shoulders up. Do not lean against wall with back. Keep feet on rungs and shoulders up. Do not lean against wall with back.  
4. Always use proper ladder technique. Always use both feet on rungs and keep both feet on rungs at any time.  
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**TAKE NO CHANCES**  
**MADE BY SEARS, ROEBUCK & CO.**  
**MADE IN U.S.A.**

## THE LIMP LADDER

## Part B

Mr. B. G. Bangs  
PDQ Insurance Company  
East Anywhere, USA

Dear Mr. Bangs:

(Observations noted in Part A)

## Discussion

It is noted (Figs. 2, 3, & 4) that the siderails of the fly section are bent and twisted in the region of overlap with the base section. The rung spacing in that portion of the fly section is 24 inches rather than 12 inches. Rungs serve a double purpose: to bear the weight of the user and to impart lateral stability to the siderails and prevent them from twisting.

This ladder bent and twisted in the region of overlap where there is minimum stability in the fly section but where maximum stress is developed on the extended ladder when in use.

It was observed that the ladder was extended to 18 feet with an overlap of 2 feet. This is in direct violation of the instructions on the ladder (See Figure 5, precaution No. 7). Using the ladder in this condition placed the portion of the fly section which lacked lateral stability (resistance to twisting) in a position of maximum stress during use. It should be pointed out that if the ladder were used with the proper amount of overlap (3 feet), the zone on the fly section with the least lateral stability (the zone with the 24 inch rung spacing) would lie within the overlap and would thus be reinforced by the base section. This would preclude twisting of the rails in this zone.

If the ladder had been used with the recommended minimum overlap, it would have been 17 feet long. The distance from the driveway pavement to the underside of the gutter is about 16 feet and 4 inches. Thus the top of the gutter is nearly 17 feet above the driveway pavement.

Precaution 7 (Fig. 5) indicates that the base of the ladder should be placed  $1/4$  of the working length (base to top support) away from the wall. To do this with the top support about 17 feet above the base requires a length of about 19 feet. Precaution 7 also recommends that the ladder "extend 3 feet above the upper support".

It is obvious that not only was the wrong ladder being used for this specific task but that it was also being misused.

#### Conclusion

The cause of the accident and damage to the ladder was a direct result of an overextended ladder being used in an improper manner.

Respectfully submitted,

J. O. E. Jones, P.E.

## Instructor's Note

## THE LIMP LADDER

Obviously, this case, like all others can be used in a variety of ways. One eminent (friendly, constructive) critic of the case, as written, has suggested that he would prefer to say that Mr. Jones has drafted the opinion given in Part B and now asks for help in:

1. Comparing the bending moments with 2 ft and 3 ft overlap.
2. Trying to imagine arguments contrary to the conclusions expressed in the draft.
3. Adding further arguments to the draft before it becomes a final letter.

This same individual has suggested two points as examples:

1. If 3 ft overlap is required, the ladder should have a positive stop when extended to 3 ft overlap. (It may have had such a stop which has been removed?)
2. The instructions, Fig. 5, are confusing by referring to ladders of different lengths, etc. Why save a nickel (or some such magnificent sum) by making "universal" instructions rather than separate ones for extension ladders of different lengths, stepladders, and wooden ladders rather than metal ones.